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GB 2265243 A GB 2217498 A WO 87/07057 A1
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(54) Automatic reading of vehicle number plates

(57) A method of monitoring information presented on a surface 11 having a high reflectivity relative to a surrounding area comprises the steps of illuminating a field of view including said surface with high intensity light 10, receiving light from said view 14, distinguishing light received from the surface from light received from the surrounding area and storing information indicative of the light received from the surface. Preferably the surface is a number plate of a vehicle, and the method further comprises recognising the alphanumeric characters presented thereon. When retro-reflective number plates are imaged using high shutter speeds such as provided by an asynchronous video CCD camera 14 with short flash illumination the background is obscured and the plate area does not need to be picked out prior to character recognition.

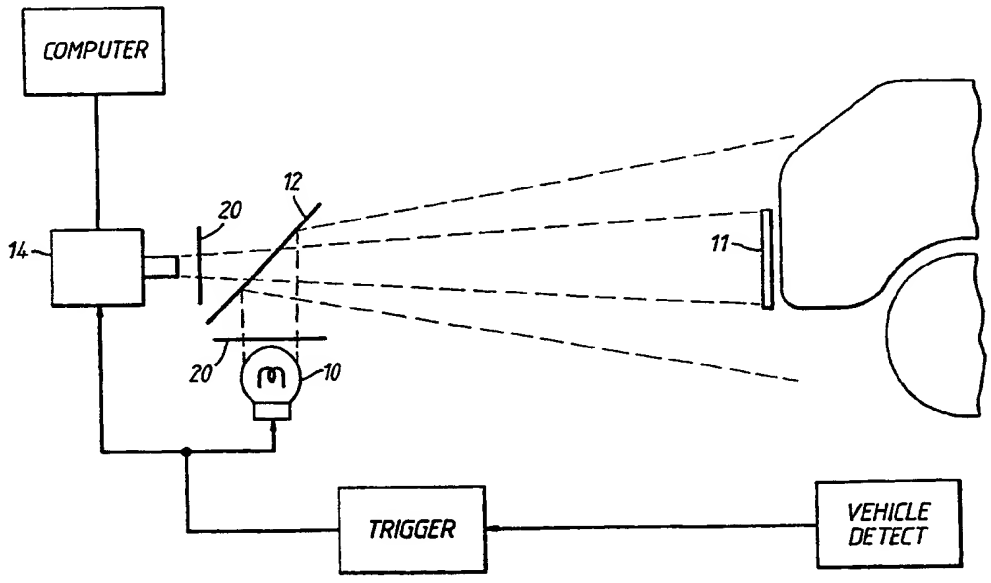

Fig.1

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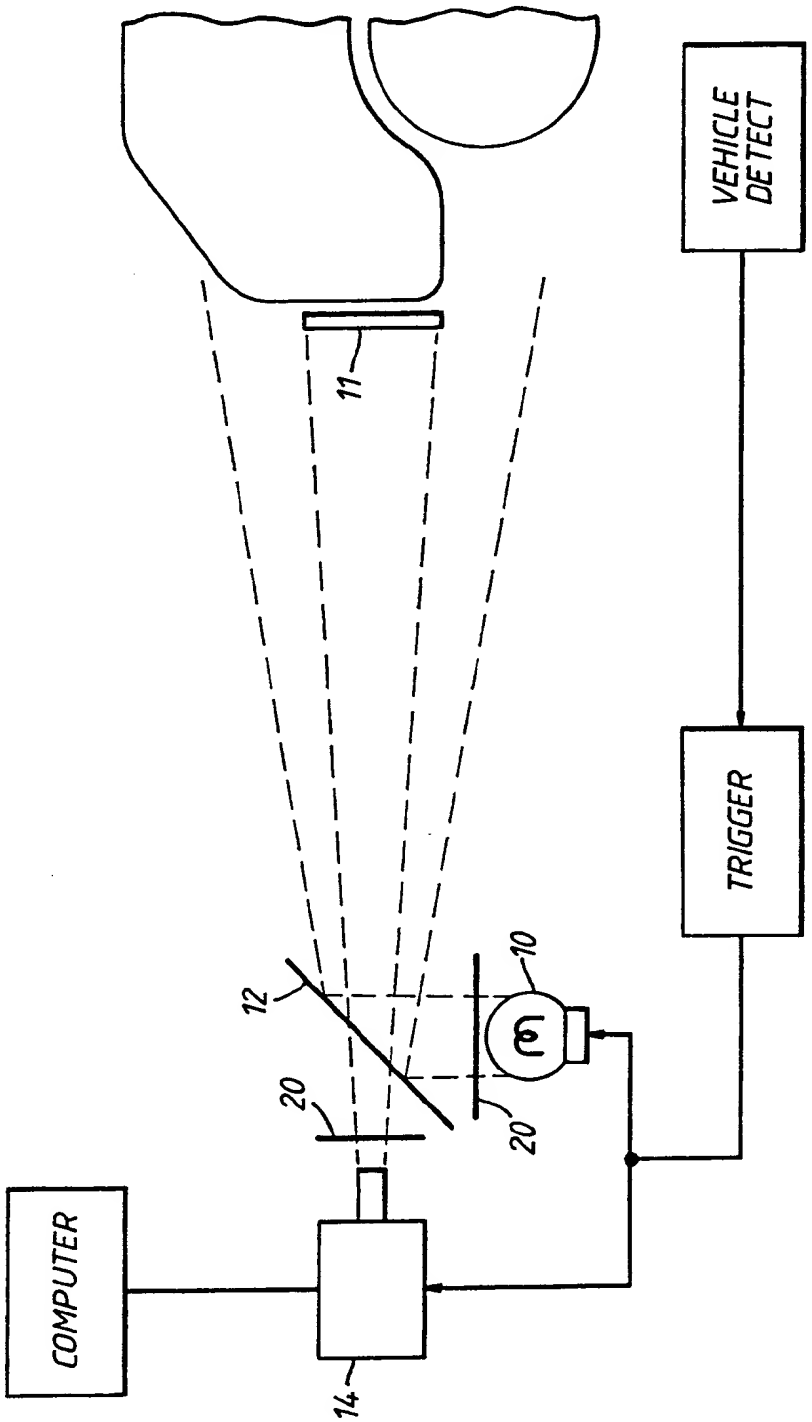

Fig.1

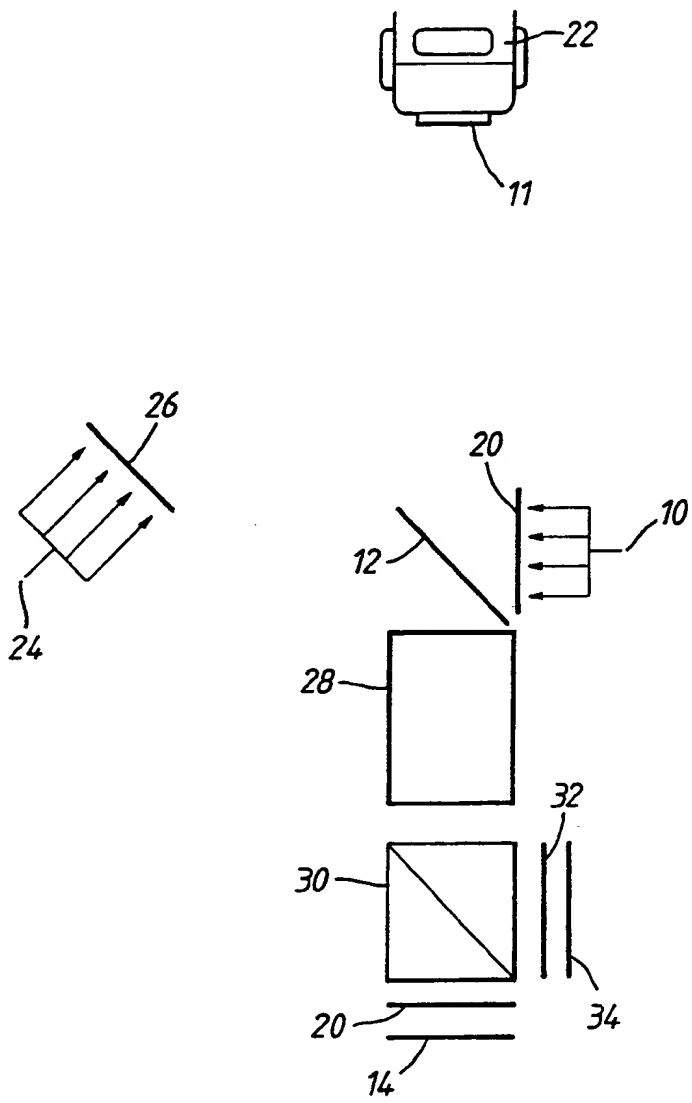

Fig.2

Object Recognition and Identification

The present invention relates to the recognition of alpha-numeric data present among other background information.

Optical character recognition is well known in the computer field where apparatus is used to optically scan documents bearing alpha-numeric characters and produce a data stream in computer readable form whereby the alpha-numeric data can be automatically and directly loaded into the computer for further processing.

It has taken many years, but now systems are available for use on documents which systems are, by and large quick and reliable.

However, there is a problem where the alpha-numeric data is part of a much larger amount of data such as graphical data. When this occurs on a document, an operator usually is present and can identify to the system the area of the document containing the alpha-numeric data. However, there are other instances where this problem may occur and where no operator will be present.

One such instance occurs in the field of motor vehicle monitoring. It is now common for vehicles on roads, at intersections and in car parks to be the subject of surveillance by cameras and for photographs or still images to be produced so that individual vehicles can be identified. Ideally the number plate of the vehicle should be readable for proper identification and ideally the number plate should be read so as to dispense with the need for an operator looking at the photograph or image and reading the plate.

There have been previous proposals for automatic reading of number plates but these have mainly relied on software processing to distinguish the

location of the number plate in the overall scene before subjecting the number plate to character recognition. This process is slow and expensive and can lead to errors if other text is close to the number plate.

An object of the present invention permits optical monitoring of objects bearing indicia in such a way that the indicia can be recognised by a computer in a speedy and inexpensive manner.

The present invention provides a method of monitoring information presented on a surface having a high reflectivity relative to a surrounding area comprising the steps of

illuminating a field of view including said surface with high-intensity light;

receiving light from said field of view;

distinguishing light received from the surface from light received from the surrounding area; and

storing information indicative of the light received from the surface.

The invention provides apparatus for monitoring information presented on a surface having a high reflectivity relative to a surrounding area, comprising

means for illuminating a field of view including said surface with high intensity light;

means for receiving light from said field of view;

means for distinguishing light received from the surface from light received from the surrounding area; and

means for storing information indicative of the light received from the surface.

The apparatus is preferably utilises an asynchronous camera with an effective shutter speed of about 1/10,000 of a second or faster e.g. 1/30,000 of a second and the illuminating means preferably provides a

high intensity flash of light arranged to have an energy peak for a period of about 1/40,000 of a second.

When the field in view includes a vehicle and the indicia is the number plate of the vehicle, this system permits an image of number plate to be viewed while the remainder of the scene is extinguished from view. Since only the number plate is "visible", a computer has little difficulty in recognising the alpha-numeric characters.

A preferred embodiment of the invention includes equipment capable of recording a colour image of the object, eg. a vehicle, in the environment.

Features and advantages of the present invention will become apparent from a description of an embodiment thereof, given by way of example with reference to the accompanying drawings in which

Figure 1 shows diagrammatically a first embodiment of number plate reading apparatus.

Figure 2 shows diagrammatically an additional embodiment of the invention. In additional to the number plate reading apparatus of the first embodiment preferred apparatus is shown for recording a colour image of the object in the target environment.

The present invention will be described in relation to its use in "reading" car number plates automatically. Car number plates consist of black alpha-numeric characters on a reflective background which is generally a retro-reflective surface which essentially consists of many thousands of part-silvered glass beads, electrostatically applied such that the mirrored half is towards the back. This results in the number plate being an extremely good reflector of incident light. This basic property is made use of in the present invention.

Figure 1 shows a diagram of the first embodiment of the apparatus where, once the presence of

a vehicle has been detected by some suitable means, light from a high intensity light source 10 is projected through a filter 20 onto a number plate 11 for example by using a semi-silvered mirror 12. The number plate is viewed through the semi-silvered mirror 12 and a second filter 20 by an asynchronous high shutter speed camera 14. It is preferred that the light source is focused through a lens of similar focal length to that of the CCIR camera 14. A ring flash could also be used which would avoid the need for the mirror 12.

It can be shown that the conventional number plate reflective material is 98% reflective if the angles of incidence and reflection are coincident and a significant amount of reflected light is available off axis. We have found that sufficient light is reflected at up to 45° off axis. Thus, in tests, the intensity of the number plate against the surrounding information is better than 8 photographic stops more intense.

The camera 14 is an asynchronous video camera with a conventional CCD chip for high resolution and capable of an effective shutter speed of 1/10,000 of a second which effectively adds 8 photographic stops to the exposure as compared with a normal camera operating at 50 fields a second which is the customary camera for surveillance activities. Because of the use of such a high speed shutter, the light source has to be capable of producing a flash of light at extremely high speed. This can be done either using a strobe lamp or a discharge tube. The requirement is, however, that the energy peak has to be extremely short and compatible with the shutter speed of the camera. Certain discharge tubes have an energy peak over a period of 1/40,000 of a second. In the present apparatus the shutter of the camera and discharge of the discharge tube are synchronised so that there is no effective loss of light returned from the discharge tube as seen by the camera. However, the ambient light in the scene being viewed is

at this point 8 stops under exposed, and this is more than enough to extinguish the scene from the view of the camera given the dynamic range of a standard CCD chip.

The intensity of light from a number plate is normally 8 photographic stops more intense than light reflected from its surroundings. Tests have shown that a number plate is in fact 8 stops more light than white card placed along side it. This, coupled with the 8 stops gained by the high speed shutter and flash synchronisation, separates the plate from the scene by at least 16 photographic stops. The effect of this is to completely obscure the background from the sight of the camera and to leave only the number plate visible to the camera.

In order that the camera can form an image of the number plate, it may be necessary to place neutral density filter material in front of the lens to effect the 16 stop difference and block out the scene surrounding the number plate.

The resulting effect of this is that there is no need to define an area of the resulting image on which to perform character recognition. In the past, it has been necessary either for a person to undertake this task or for complex processing to take place in order to ignore symbols other than an expected character-set. When utilising the presently described apparatus, the information presented on the number plate may be present in the only light signal registered by the camera, thus removing the need for any further processing prior to the character recognition steps.

In particular with number plates, which are generally retro-reflective, if the light source and camera are not positioned on a light-path perpendicular to other reflective parts of the car or field of view, it can be arranged that no light other than that reflected by the number plate is even directed towards

the camera, let alone registered. This relies on an absence of ambient light, but the situation could be simulated by utilising a light source of wavelengths not present in the ambient light, and receiving light only of such wavelengths.

Alternatively, optical band pass filters 20 may be applied to the output from the light source 10 and the input to the camera 14 to effectively remove from them the visible spectrum and to reduce disturbance caused by the flash. This usually means that the camera will be a CCIR type of camera.

The output from the camera can be fed as an electrical output to a processor. The light received from the scene need never be stored as an actual image. All the processor then receives is electrical signals indicative of the image of the number plate and it is then possible for it to decode the electrical signals it receives and recognise alpha-numeric characters. There can be a hard wired link between the apparatus and the processor or the processor can be part of the apparatus. A wireless link to other equipment can be provided.

It has been shown that this system is capable of operating successfully at an angle of up to 45° of horizontal and in this event an off axis optical alignment could be used to present a perspectively correct image to the CCD chip as used in plate camera photography. The system is effective over a large range of distances and it is possible to fit the camera with a zoom lens.

A further improvement would be to link the operation of the CCIR camera and flash with a conventional surveillance camera so that a photograph or still image could be produced simultaneously with the reading of the number plate.

The above modification of use of a zoom lens

and stills photographs are incorporated in a second embodiment which will now be described in relation to Figure 2 where the same reference numbers refer to the same parts.

Figure 2 shows a diagram of a preferred embodiment of the invention. The black and white CCD sensor 14 and a further sensor in the form of a colour CCD sensor 34 are both controlled by an asynchronous drive and are designed to integrate simultaneously and fire two light sources in the form an offset light source 24 and the coincident light 10 at the same instant. Once the presence of a vehicle has been detected by some suitable means, the offset light source eg. a white light flash 24 and coincident light source 10 are simultaneously activated. The coincident light source 10 illuminates the number plate 11 only, enabling a mask to be generated by the image processor from the image of the number plate 11 to be produced by the black and white CCD sensor in the same manner as described in the first embodiment. The white light flash 24 illuminates the vehicle 22 which is viewed through the semi-silvered mirror 12, a lens 28 and a beamsplitting prism 30 by the asynchronous high resolution colour CCD sensor 34 which has an infra-red cut filter 32 in front of it. At the same instant that the mask is produced by the black and white CCD sensor 14, the colour CCD sensor 34, using application software, records a high resolution colour image of the scene. The entire scene may then be committed to a storage medium. The zoom lens 28 allows enlarged masked and colour images to be recorded by the black and white CCD 14 and the colour CCD 34 respectively, improving the quality and therefore allowing easier recognition by computer. The mask generated by the black and white CCD sensor is then used to extract the number plate from the high resolution colour image. This is then processed as appropriate.

While the system has been described in relation to reading number plates of motor vehicles, a label or other plate could be attached to other objects for identification purposes to enable optical reading of the label by a computer.

The light sources 10 and 24 may be white light sources or one or both could be of a specific frequency bandwidth such as infra-red. Also, the CCD sensors may be black and white or colour as is convenient for the purpose to which the apparatus is to be put.

Further, although asynchronous cameras are disclosed, it is also possible to use synchronous cameras.

CLAIMS

1. A method of monitoring information presented on a surface having a high reflectivity relative to a surrounding area comprising the steps of

illuminating a field of view including said surface with high-intensity light;

receiving light from said field of view;

distinguishing light received from the surface from light received from the surrounding area; and

storing information indicative of the light received from the surface.

2. A method according to claim 1, wherein the light received from the field of view is distinguished on the basis of different intensities.

3. A method according to claim 2, wherein the light received from the field of view is filtered in order to distinguish light of different intensities.

4. A method according to any of claims 1 to 3, wherein the information is stored in the form of electrical signals.

5. A method according to claim 4, wherein the electrical signals are derived by a video camera.

6. A method according to any of claims 1 to 5 wherein information is stored as an image formed by a video camera.

7. A method according to any of claims 1 to 6, further comprising a step of performing character recognition on the stored information.

8. A method according to any of the preceding claims further comprising a step of creating a second image of a field of view including said surface.

9. A method according to claim 8, wherein said second image is a photographic image.

10. A method according to claim 8 or 9, wherein said second image is a colour image.

11. Apparatus for monitoring information presented on a surface having a high reflectivity relative to a surrounding area, comprising

means for illuminating a field of view including said surface with high intensity light;

means for receiving light from said field of view;

means for distinguishing light received from the surface from light received from the surrounding area; and

means for storing information indicative of the light received from the surface.

12. Apparatus according to claim 11, wherein the distinguishing means distinguishes light from the field of view on the basis of different intensities.

13. Apparatus according to claim 12, wherein the distinguishing means includes means for filtering the light received from the field of view in order to distinguish light of different intensities.

14. Apparatus according to claim 11, 12 or 13, wherein the storing means stores information in the form of electrical signals.

15. Apparatus according to claim 14, wherein the storing means comprises a video camera.

16. Apparatus according to any of claims 11 to 15, wherein information is stored as an image formed by a video camera.

17. Apparatus according to any of claims 11 to 16, further comprising means for performing character recognition on the stored information.

18. Apparatus according to any of claims 11 to 17, further comprising means for creating a second image of a field of view including said surface.

19. Apparatus according to claim 18, wherein said image-creating means is a photographic means.

20. Apparatus according to claim 18 or 19, wherein said image-creating means is for creating a colour image.

21. A method of monitoring information substantially as hereinbefore described with reference to Figures 1 and 2.

22. Apparatus for monitoring information substantially as hereinbefore described with reference to Figures 1 and 2.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report) 12	Application number GB 9412589.5
Relevant Technical Fields (i) UK Cl (Ed.M) G1A (AMHL, AMK) G4R (RET, REX, RPX) G4Q (QCB) (ii) Int Cl (Ed.5) G06K 9/00, 9/20; G08G 1/017	Search Examiner H J EDWARDS Date of completion of Search 22 SEPTEMBER 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE: WPI	Documents considered relevant following a search in respect of Claims :- 1 TO 22

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X, P	GB 2265243 A	(TAYLOR-LANN) page 4 lines 24-28; page 11 lines 12-19	1, 2, 4-7, 11, 12, 14-17
Y	GB 2217498 A	(INDUSTRIAL TECHNOLOGY) illumination 21, 22; plate location page 6 line 35 et ff	1, 4-7, 11, 14-17
Y	WO 87/07057 A1	(PERCEPTICS) illumination 24; plate location 100	1, 4-7, 11, 14-17
X, Y	US 4908500	(BAUMBERGER) column 1 lines 50-62; column 2 lines 16-25, 60-66	1, 2, 4-7, 11, 12, 14-17
X	US 4731854	(GONZALEZ) illumination 18; column 2 lines 20-41	1-7, 11-17

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